DOCUMENT RESUME

ED 135 603 SE 021 912

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TITLE Ways to Bring a "Far Out" Subject SPACE BIOLOGY Into the Classroom.
PUB DATE Nov 75
NOTE 20p.; A 1976 Science Teaching Achievement Recognition (STAR) Award winning paper; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS Biological Sciences; *Biology; *Curriculum; *Science Courses; Science Education; Secondary Education; *Secondary School Science; *Space Sciences

ABSTRACT

This document describes a grade 10-12 biology course designed to increase student interest by introducing topics in space biology including: the book "Andromeda Strain"; weightlessness; centrifuge; cosmic radiation; space research; origins of life; extraterrestrial life; and the Mars Viking Mission. (SL)

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"Ways to Bring A "Far Out" Subject SPACE BIOLOGY Into the Classroom

Submitted by

Janice Lamb

November 1975

SE 021 912

"WAYS TO BRING A "FAR OUT" SUBJECT SPACE BIOLOGY INTO THE CLASSROOM"

ALTHOUGH SPACE TOPICS ARE OFTEN INCLUDED IN PHYSICAL SCIENCE CURRICULUM, I HAVE FOUND THAT FEW BIOLOGY TEACHERS INCLUDE SPACE BIOLOGY TOPICS IN THEIR COURSES. TEXTBOOKS FOR BIOLOGY GIVE ONLY SLIGHT REFERENCES. I, TOO, WAS NOT AWARE OF THE MANY WAYS THAT ONE COULD STIMULATE INTEREST IN BIOLOGY THROUGH SPACE BIOLOGY, UNTIL I ATTENDED A NATIONAL SCIENCE FOUNDATION SUMMER INSTITUTE AT AMES SPACE RESEARCH CENTER IN CALIFORNIA (1970). SINCE THAT SUMMER, I HAVE BEEN WORKING ON WAYS TO MAKE SPACE BIOLOGY A PART OF MY COURSES. IT STARTED OUT AS AN ATTEMPT TO SHARE WITH MY STUDENTS SOME OF THE EXCITING EXPERIENCES OF THE SUMMER AT AMES. SINCE THEN, THINGS HAVE MUSHROOMED AND MANY NEW IDEAS HAVE BEEN TRIED AND ADDED. AS I HAVE COMPILED MATERIALS, I HAVE FOUND THAT MANY SOURCES ARE AVAILABLE.

LAST YEAR, I WAS ASKED TO BE A CONSULTANT FOR THE COLLEGE BOARD (CEEB) ADVANCED PLACEMENT PROGRAM IN THE SOUTHERN REGION. THE PURPOSE IS TO HOLD WORKSHOPS FOR TEACHERS TO ASSIST THEM IN DEVELOPING CURRICULUM FOR TEACHING AP BIOLOGY. TO SHARE WITH THE AP TEACHERS IN THE WORKSHOPS SOME OF THE IDEAS AND MATERIALS DEVELOPED WITH MY STUDENTS, A BOOKLET TITLED "ADVANCED PLACEMENT SPACE BIOLOGY" WAS COMPILED. ALTHOUGH THE TITLE INDICATES THEIR USE BY AP STUDENTS, THE IDEAS AND METHODS ARE WIDELY APPLICABLE AND HAVE BEEN USED IN PART WITH ALL MY BIOLOGY CLASSES GRADES 10-12. BELOW, I SHALL LIST TOPICS, LABS, QUESTIONS AND VARIOUS APPROACHES THAT CAN BE USED TO INTRODUCE SPACE BIOLOGY.

1. THE FIRST NINE WEEKS STUDENTS ARE ASKED TO READ THE ANDROMEDA STRAIN BY MICHAEL CRICHTON. ONE YEAR, WE WENT AS A

CLASS TO SEE THE MOVIE. THIS IS AN EXCELLENT BOOK FOR USE IN ANY BIOLOGY CLASS TO STIMULATE INTEREST. IT WILL "TURN THE STUDENTS ON" AND GET THEM EXCITED ABOUT BIOLOGY. AFTER THE SUMMER AT AMES THE "ANDROMEDA STRAIN" DOESN'T SEEM SO "FAR OUT."

2. I START THE YEAR SHOWING SLIDES TAKEN AT AMES OF THE LARGE CENTRIFUGES, LABS WITH ELECTRON MICROSCOPES AND VARIOUS CHAMBERS USED TO SIMULATE CONDITIONS ON OTHER PLANETS. THEY ARE AMAZED TO LEARN ABOUT THE LARGE CENTRIFUGES FROM THE SMALL EIGHT FOOT MODEL I USED, TO THE GIANT FIFTY FOOT DIAMETER CENTRIFUGE. ON THESE GIANT CENTRIFUGES, RATS, RABBITS AND DOGS ARE CENTRIFUGED IN CAGES ON LONG SPOKE-LIKE ARMS. THE ANIMALS CAN BE MONITORED BY CLOSED CIRCUIT TV AND THEIR TEMPERATURE AND HEART BEAT IS RECORDED CONTINUOUSLY TO KEEP TABS ON THEIR REACTIONS TO STRESS OF HIGH G'S. THE FIFTY FOOT DIAMETER CENTRIFUGE WITH ITS OWN AIR CONDITIONING AND WATERING SYSTEMS CAN CENTRIFUGE ANIMALS CONTINUOUSLY WITHOUT ANY STOPPAGE WHATSOEVER. WE TALK ABOUT THE STRANGE CASE AT AMES WHERE A MAN WAS CENTRIFUGED. HE HAD A BULLET IN THE VENTRICLE OF HIS BRAIN WHICH COULDN'T BE REMOVED SURGICALLY. DURING CENTRIFUGATION THE BULLET MOVED AS CALCULATED, AND WAS LATER REMOVED BY SURGERY.

3. AFTER SHOWING AMES SLIDES, EACH STUDENT IS GIVEN A COPY OF MY RESEARCH PAPER. STUDENTS ARE ASKED TO GUESS WHAT MY RESEARCH WAS ABOUT BY LOOKING AT THE TITLE, "HYPOTHERMIA RATS SUBJECTED TO ACUTE CENTRIFUGATION." WE TALK ABOUT HOW I WENT ABOUT FORMING HYPOTHESES. WITH COPY IN HAND, STUDENTS ARE ASKED TO INTERPRET DATA CHARTS AND GRAPHS, THEY ARE ASKED TO TELL ME, BASED ON CHARTS AND GRAPHS, WHAT I FOUND FROM DOING THE RESEARCH. THEY CONTRIBUTE MANY IDEAS ABOUT HOW THE HYPOTHESIS COULD BE FURTHER TESTED. THE GOAL IS TO BUILD ENOUGH BACKGROUND SO THE STUDENTS CAN HANDLE THE GRAPHS,

BUT NOT TO GIVE THE FINDINGS AWAY. ANY RESEARCH PAPER COULD BE USED BUT IT IS SPECIAL WHEN A TEACHER USES HIS PAPER. THE TEACHER'S ENTHUSIASM CAN BE "CONTAGIOUS" AS HE TALKS ABOUT THE BLOOD, SWEAT AND TEARS INVOLVED IN DOING HIS RESEARCH. MY STUDENTS ENJOY THE LITTLE STORIES ABOUT THE DAY RAT # FIVE BIT ME AND HOW I HAD TO WORK TO OVERCOME MY FEAR OF RATS. AFTER LEARNING HOW TO DO ADRENALECTOMIES, ONE OF MY RAT'S STITCHES KEPT COMING OUT. AFTER PUTTING THE STITCHES IN SEVERAL TIMES, I WAS EXASPERATED. FINALLY I DISCOVERED THE PROBLEM. THE OTHER RAT IN THE CAGE WITH THE VICTIM WAS TAKING HIS STITCHES OUT. WHEN THE GUILTY RAT WAS REMOVED, THE STITCHES REMAINED INTACT. THROUGH THE DISCUSSION OF MY RESEARCH PAPER, THE STUDENTS GAIN VALUABLE INSIGHT INTO HOW A SCIENTIST WORKS (SCIENTIFIC METHOD), AND ALSO GAIN SOME APPRECIATION FOR THE HARD, TEDIOUS WORK WHICH IS INVOLVED IN RESEARCH.

4. THE PROBLEMS OF WEIGHTLESSNESS AND SPACE PHYSIOLOGY. THERE ARE MANY PROBLEMS BEING RESEARCHED ABOUT SPACE PHYSIOLOGY. ALL OF OUR ASTRONAUTS HAVE BEEN PLAGUED BY MOTION SICKNESS. IT IS NOT UNDERSTOOD WHAT HAPPENS TO THE FLUID IN THE INNER EAR (UTRICLE AND SEMICIRCULAR CANALS) DURING WEIGHTLESSNESS. THERE IS MUCH CONCERN ABOUT THE WEAKENING EFFECT ON HEART MUSCLE ON LONG SPACE VOYAGES. IT MAY BE THAT ASTRONAUTS WILL HAVE TO STOP OFF AND GO THROUGH A PHYSICAL BUILD-UP PROGRAM TO STRENGTHEN THE HEART BEFORE RE-ENTRY TO PREVENT POSSIBLE FATALITIES. WHY ARE THEY GETTING AWAY FROM USING 100% OXYGEN IN SPACE SHIPS? OXYGEN IS USED LESS AND WITH CAUTION ON HEART ATTACK VICTIMS. THE PROBLEMS OF BLINDNESS FROM PURE OXYGEN GIVEN TO PREMATURE INFANTS IN THE PAST AND DAMAGE TO THE RETINA ARE DISCUSSED. ONE OF

TEACHERS IN THE INSTITUTE WORKED ON THIS VERY PROBLEM. SHE FOUND STRIKING DIFFERENCES BETWEEN THE LYSOSOMES OF CONTROL CELLS AS COMPARED WITH THOSE TREATED WITH 100% OXYGEN. THERE ARE OTHER PROBLEMS OF PROLONGED SPACE TRAVEL. WE KNOW THAT IT RESULTS IN THE LOSS OF CALCIUM FROM BONES. NOT ONLY DO RESEARCHERS WORRY ABOUT WEAK BONES, BUT THEY ARE ALSO ANXIOUS ABOUT WHERE THE CALCIUM GOES. IT COULD POSSIBLY FORM KIDNEY STONES. WHAT A PROBLEM THIS WOULD BE ON A LONG SPACE VOYAGE.

5. CENTRIFUGES CAN BE USED TO STUDY WEIGHTLESSNESS. OTHER THAN FREE FALL, IT IS IMPOSSIBLE TO SIMULATE WEIGHTLESSNESS ON EARTH. COMPLETE BED REST STUDIES SHOW PATIENTS WITH SYMPTOMS SIMILAR TO THOSE OF WEIGHTLESSNESS. THE RUSSIANS DID MUCH OF THE EARLY WORK ON THE EFFECTS OF INCREASED GRAVITY. ANIMALS WERE SENT UP IN SMALL ROCKETS. DR. JIRO OYAMA AT AMES IS AN AUTHORITY IN THE AREA OF CENTRIFUGATION. HE DIRECTED MY RESEARCH AND I BECAME FAMILIAR WITH SOME OF THE INTERESTING WORK HE IS DOING. FOR EXAMPLE, HE HAS RAISED THREE GENERATIONS OF "EXTRA TERRESTRIAL MICE" AS HE CALLS THEM WHO HAVE BEEN BORN, BRED AND LIVED THEIR ENTIRE LIVES AT 2 1/2 G'S, THE FORCE OF GRAVITY ON THE PLANET JUPITER. BY TAKING THEM OFF THE MACHINE, HE CAN STUDY THE REDUCTION FROM 2 1/2 G'S TO 1 G WHICH WILL GIVE INSIGHT INTO THE DROP FROM 1G TO 0 G. OYAMA HAS DISCOVERED ONE STRIKING DIFFERENCE BETWEEN HIS HIGH-G ANIMALS AND THEIR EARTHBOUND COUNTERPARTS. THE HIGH G ANIMALS GROW SLOWER, ARE SMALLER AND HAVE LESS BODY FAT. HERE IS A GREAT CHANCE TO STUDY OBESITY SINCE THEY ARE BOTH LEAN AND OVERWEIGHT. THEIR BODY FAT IS LOW AND YET THEIR WEIGHT IS 2 1/2 TIMES NORMAL. THERE IS SOME INDICATION THAT HIGH G ANIMALS MAY EVEN LIVE LONGER.

WE ARE ALL INTERESTED IN LONGEVITY STUDIES. THE CENTRIFUGE IS A USEFUL TOOL IN STUDYING STRESS. WITH THE INCREASE OF STRESS DISEASES SUCH AS ULCERS, HYPERTENSION, THE CENTRIFUGE MAY HELP EXPLAIN SOME OF THESE IN THE FUTURE.

6. THE DANGER OF COSMIC RADIATION TO ASTRONAUTS ON LONG VOYAGES. AN INTERESTING DISCUSSION CAN BE CENTERED AROUND THE EFFECT OF RADIATION EXPOSURE TO THE HUMAN ORGANISM. WE MAY HAVE TO SET UP "SPERM BANKS" FOR ASTRONAUTS IF THEY WANT TO HAVE CHILDREN AFTER THEIR VOYAGE. THE POSSIBLE CHROMOSOME DAMAGE POSES A BIZARRE PROBLEM.

7. "SPIN OFF" BENEFITS OF SPACE RESEARCH. THIS IS A VERY GOOD OPPORTUNITY TO TALK ABOUT PURE RESEARCH VS APPLIED RESEARCH. TO STRESS THE NEED FOR FINANCIALLY SUPPORTING RESEARCH, ONE CAN TALK ABOUT THE "SPIN OFF" THINGS BEING USED IN MEDICINE TODAY WHICH WERE DEVELOPED IN SPACE RESEARCH. ONE EXAMPLE WHICH COULD BE USED, WOULD BE THE LATEST TELEMETRY FOR HEART ATTACK VICTIMS IN INTENSIVE CARE UNITS. THIS ALLOWS PATIENTS GREATER MOBILITY WHILE THEIR HEARTS ARE BEING MONITORED. THIS SYSTEM WAS DEVELOPED AND USED BY THE ASTRONAUTS. WE HAVE A RESPONSIBILITY TO TEACH LAY PEOPLE AS WELL AS SCIENTISTS. MANY OF OUR STUDENTS WILL BE POLITICIANS, LEGISLATORS AND WILL MAKE VITAL DECISIONS WHICH AFFECT OUR BIOSPHERE. IF WE ARE GOING TO HAVE SUFFICIENT FINANCIAL BACKING FOR RESEARCH, SCIENTISTS ARE GOING TO HAVE TO EDUCATE THE PEOPLE TO THIS NEED. SCIENTISTS CAN NO LONGER STAY IN THEIR "IVORY TOWERS." WE MUST PRODUCE FUTURE CITIZENS WHO WILL NOT BE AFRAID OF SUBJECTS LIKE NUCLEAR ENERGY AND WILL HAVE SOME GENERAL KNOWLEDGE TO HELP THEM UNDERSTAND THE PROBLEMS OF THE FUTURE.

8. THINGS TO LOOK FORWARD TO IN FUTURE SPACE RESEARCH.

NOW THAT WE HAVE GONE TO THE MOON, WHAT CAN WE LOOK FORWARD TO IN FUTURE SPACE RESEARCH? THROUGH THE SPACE SHUTTLE PROGRAM, LABS IN SPACE CAN BECOME VERY SPECIALIZED "FACTORIES" TO PRODUCE THINGS NOT POSSIBLE ON EARTH. THE SKYLAB PROGRAM, AN ORBITAL HOME OCCUPIED BY THREE THREE-MAN ASTRONAUT TEAMS IN 1973 AND 1974 PROVED CONCLUSIVELY THAT MAN CAN LIVE AND PERFORM USEFUL TASKS IN ORBIT. THEY WERE ABOARD FOR 28, 59 AND 84 DAYS. ABOARD ONE OF THESE MISSIONS A VERY SPECIAL FEAT WAS ACCOMPLISHED. A SPECIAL INDIUM-ANTIMONIDE CRYSTAL WAS FORMED . THE CRYSTAL WAS PARTIALLY MELTED IN A SKYLAB VACUUM FURNACE AND WAS THEN RESOLIDIFIED. SCIENTISTS SAY THE CRYSTAL IS THE PUREST AND MOST DURABLE YET PRODUCED BY MAN. SUCH A CRYSTAL, USED TO CARRY ELECTRIC CURRENT INSIDE A HANDCOMPUTER, WOULD MAKE IT POSSIBLE TO REDUCE THE COMPUTER TO ONE-TENTH ITS PRESENT SIZE-----TO ABOUT THE SIZE OF A POSTAGE STAMP. EXPERTS SAY THE EXPERIMENTS COULD LEAD TO OPERATIONAL MANUFACTURING IN SPACE STATIONS OF SUCH PRODUCTS AS HIGH TEMPERATURE TURBINE BLADES; SUPERIOR TOOL INSERTS AND TIPS THAT WOULD LOWER THE MACHINING COST FOR AUTOS AND OTHER VEHICLES; NEW STRUCTURAL COMPONENTS WITH GREATER STIFFNESS, STRENGTH AND DENSITY; AND PERFECTLY ROUND BALL BEARINGS, LONG SOUGHT BY INDUSTRY.

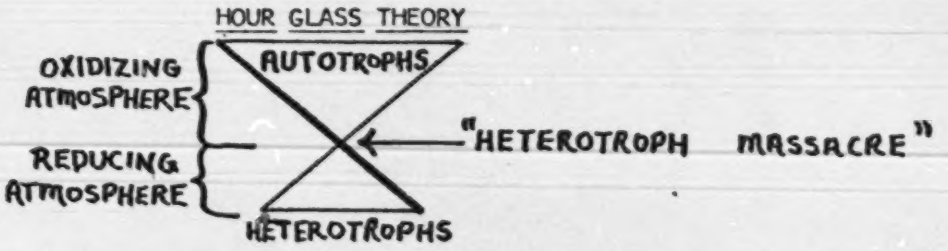
NASA FORESEES IN THE SHUTTLE AREA THAT OIL AND MINERAL COMPANIES WILL WANT TO SEND THEIR OWN TEAMS OF RESEARCHERS INTO SPACE. SKYLAB PHOTOS HAVE YIELDED CLUES TO NEW MINERAL RESOURCES THAT MAY ULTIMATELY BE WORTH MORE THAN THE ENTIRE U. S. SPACE PROGRAM TO DATE. THREE POTENTIAL OIL DEPOSITS DETECTED IN CALIFORNIA AND A COPPER DEPOSIT LOCATED IN

NEVADA ARE ESTIMATED TO BE WORTH SEVERAL BILLION DOLLARS. IN MEDICINE THEY ARE CONSIDERING THE UNIQUE PROPERTIES OF SPACE TO PRODUCE PURE VACCINES AND OTHER DRUGS AND MEDICINES. THE SPACE SHUTTLE IS SET TO BEGIN FLIGHT IN 1979. IT WILL BE LAUNCHED LIKE A ROCKET, FLY LIKE A SPACECRAFT AND LAND BACK ON EARTH LIKE AN AIRPLANE. IT WILL BE RE-USABLE AND WILL BE FLOWN 100 OR MORE TIMES.

9. THE CHEMICAL EVOLUTION APPROACH TO THE ORIGIN OF LIFE.

WHAT IS THE ORIGIN OF LIFE? WHICH CAME FIRST HETEROTROPHS OR AUTOTROPHS? WHEN DID LIFE FIRST COME ABOUT AND WHAT FORM WAS IT? CHEMICAL EVOLUTIONISTS SUCH AS DR. CYRIL PONNAMPERUMA AND DR. SIDNEY FOX, TRY TO SIMULATE CONDITIONS ON THE PRIMITIVE EARTH IN LABORATORIES TO FIND THE ANSWERS TO THE ABOVE QUESTIONS. THEY ALSO SEARCH FOR MICROFOSSILS AND CHEMICAL FOSSILS IN VOLCANIC LAVA, METEORITES AND MOON ROCK. ONE OF THE BEST DEVICES I HAVE FOUND TO EXPLAIN THE ORIGIN OF LIFE IS THE "HOUR GLASS THEORY." MY STUDENTS SEEM ABLE TO GRASP THIS COMPLEX SUBJECT USING THIS APPROACH. THIS WAS FIRST PRESENTED TO ME BY DR. PONNAMPERUMA IN A LECTURE. THE "HOUR GLASS THEORY" SAYS THAT HETEROTROPHS PRECEDED AUTOTROPHS. HETEROTROPHS THRIVED FOR MANY YEARS ON THE ORGANIC SOUP IN THE OCEANS. THIS ORGANIC SOUP WAS FORMED BY CHEMICAL SYNTHESIS FROM THE PRIMITIVE GASES FOUND IN THE PRIMITIVE EARTH ATMOSPHERE. THE GASES WERE HYDROGEN, WATER VAPOR, METHANE AND AMMONIA. THE PRIMARY ENERGY SOURCE WAS ULTRAVIOLET RADIATION FROM THE SUN. SECONDARY ENERGY SOURCES WERE LIGHTNING (SIMULATED BY MILLER-UREY), HEAT FROM THE VOLCANOES AND GAMMA RADIATION. OVER MANY, MANY YEARS THE UV CAUSED A SPLITTING OF WATER AND THE RESULT WAS THE FORMATION OF THE OZONE SHIELD. THE HETEROTROPHS LIVED FOR AWHILE ON THE ORGANIC SOUP

BUT FILTERING EFFECT OF THE OZONE SHIELD CUT OUT THE UV AND STOPPED CHEMICAL SYNTHESIS. THE HETEROTROPHS RAN OUT OF FOOD. THIS PERIOD IS CALLED THE HETEROTROPH MASSACRE (REPRESENTED BY THE NARROWING OF THE HOUR GLASS.) A FEW MUTANTS WERE ABLE TO MAKE USE OF THE LONGER WAVE LENGTHS TO MAKE THEIR FOOD AND WERE ABLE TO SURVIVE. THESE AUTOTROPHS EVOLVED INTO THE WIDE VARIETY OF LIFE ON EARTH TODAY. FOR MORE DETAILED DISCUSSION READ PAGES 9 AND 10 IN SPACE BOOKLET.



THIS YEAR, THE CONTROVERSIAL PROBLEM OF AEROSOL SPRAYS DAMAGING THE OZONE SHIELD WAS INTRODUCED. STUDENTS SEEM TO UNDERSTAND AND GRASP THE PROBLEM BASED ON THE BACKGROUND DISCUSSED IN THE "HOUR GLASS THEORY" AND THE DISCUSSION OF THE HARSH MARTIAN ENVIRONMENT WITH ITS INTENSE UV EXPOSURE.

10. EXTRATERRESTRIAL LIFE OR LIFE ON OTHER PLANETS.

AN INTERESTING DISCUSSION CAN BE BUILT AROUND THE FOLLOWING: IF YOU BUILT A CHAMBER TO SIMULATE CONDITIONS ON MARS, WHAT WOULD IT INCLUDE? IF LIFE DOES EXIST ON MARS WHAT DOES IT LOOK LIKE? WHAT ARE SOME VERY HARSH CONDITIONS THE "ORGANISM" WOULD HAVE BEEN EXPOSED TO? FOR EXAMPLE, MAYBE THE LIFE FORM SOLVED THE PROBLEM OF THE INTENSE UV BOMBARDMENT BY DEVELOPING A GLASSY SKELETON MUCH LIKE A DIATOM.

11. THIS YEAR THERE WILL BE MUCH WRITTEN ABOUT THE VIKING PROJECT. SCHEDULED TO LAND IN JULY 1976 ON MARS, IT WILL LAND, SCOOP UP SOIL AND ANALYZE SOIL FOR LIFE. USING THE BOOK THE ANDROMEDA STRAIN, FOR

BACKGROUND, WE DISCUSS HOW ONE CAN TEST FOR LIFE. THIS LEADS TO A DISCUSSION OF THE CHARACTERISTICS OF LIVING THINGS. STUDENTS ARE MADE AWARE THAT DEFINING LIFE IS NOT SO EASY. WE TALK ABOUT THE EQUIPMENT ABOARD THE VIKING, NOW ON ITS WAY TO MARS AS WHAT TESTS THEY PLAN TO DETECT LIFE. THE ARTICLES "LIFE LAB", TIME 1974 AND "LOOKING FOR LIFE ON MARS", TIME AUGUST 17, 1975 ARE BOTH EXCELLENT ARTICLES TO HAVE STUDENTS READ FOR BACKGROUND CONCERNING THIS.

12. AN APPROACH TO OUTSIDE READING.

THERE IS A VAST AMOUNT AMOUNT OF MATERIAL AVAILABLE ON SPACE BIOLOGY TOPICS IF THE TEACHER HAS A METHOD FOR HANDLING IT. MOST TEACHERS HAVE GONE THROUGH THE HEADACHE OF TRYING TO FIND A WAY TO ENCOURAGE OUTSIDE READING OF MAGAZINES, NEWSPAPERS AND BOOKS. YOU CAN HAVE A LARGE AMOUNT OF MATERIAL IN YOUR ROOM BUT IF YOU DON'T HAVE A SYSTEM WHICH PUTS THE MATERIAL IN THE HAND OF THE STUDENT IT IS OF LITTLE VALUE. MOST CHECK OUT SYSTEMS END UP WITH ARTICLES BEING LOST AND TAKING TOO MUCH TIME OF THE TEACHER. AFTER MANY YEARS OF STRUGGLING WITH THIS PROBLEM, WE HAVE FINALLY WORKED OUT A SYSTEM. THE SYSTEM WORKS THIS WAY. EACH NINE WEEKS STUDENTS ARE ASKED TO READ A CERTAIN NUMBER OF ARTICLES RELATED TO TOPICS COVERED THAT PERIOD. THEY ARE GIVEN A READING LIST CONTAINING BOTH REQUIRED AND OPTIONAL READINGS. ARTICLES REQUIRED FOR AP STUDENTS ARE IDENTIFIED. TO GET ENOUGH COPIES OF THE ARTICLES, PARENTS XEROX COPIES FOR ME; STUDENTS BRING ME COPIES OF CURRENT ARTICLES; I COPY SOME BY THERMOFAX OR ORDER REPRINTS FROM TIME OR SCIENTIFIC AMERICAN. LAB AIDES PUT THE ARTICLES IN FOLDERS AND PLACE POCKETS AND CARDS FOR CHECK OUT. THE LIBRARY HANDLES THE

CHECK OUT OF THE ARTICLES. STUDENTS MAY CHECK OUT ARTICLES ON AN OVERNIGHT OR WEEKEND BASIS. WITH APPROXIMATELY TWO HUNDRED FOLDERS PER NINE WEEK PERIOD FOR THE LIBRARY TO HANDLE THE SITUATION BECAME CUMBERSOME AND UNWIELDLY. THE ARTICLES TO BE CHECKED OUT WERE GETTING MIXED UP WITH ONES THAT HAD NOT BEEN CHECKED IN AND WITH OTHER LIBRARY BOOKS. TO SOLVE THIS PROBLEM, TWO LARGE BOXES WERE SET UP. THE CHECK-OUT BOX CONTAINS ARTICLES IN FOLDERS INDEXED BY TITLE. STUDENTS CAN QUICKLY FIND THE ARTICLE THEY WANT, FILL IN CARD AND GIVE TO THE LIBRARIAN. THE OTHER BOX, A CHECK-IN BOX, IS TO RECEIVE THE FOLDERS WHEN THEY ARE RETURNED. THIS HAS MADE THE HANDLING EASIER AND MUCH MORE ORGANIZED FOR THE LIBRARY. AFTER STUDENTS READ THE ARTICLES THEY EITHER ABSTRACT THE ARTICLES OR ANSWER QUESTION SHEETS WHICH ARE ATTACHED TO THE INSIDE OF THE FOLDERS. A MAIN PART OF THE SYSTEM INVOLVES KEEPING THE EXTRA READING MATERIALS UP TO DATE AND RELEVANT.

13. A GOOD OUTSIDE RESOURCE TO USE IN SPACE BIOLOGY IS BELL TELEPHONE COMPANY. THE BELL TELEPHONE COMPANY HAS A SYSTEM WHERE A TEACHER CAN ORDER SLIDES FROM NASA TO SHOW CLASSES. AFTER SHOWING THE SLIDES, THE TELEPHONE COMPANY WILL ARRANGE WITH A SCIENTIST AT NASA TO TALK TO SCIENCE CLASSES. WE PLAN TO TRY TO GET A HOOK UP WITH DR. PONNAMPERUMA OR DR. OYAMA. ALL THE STUDENTS FEEL THEY KNOW THESE PEOPLE. THROUGH THIS SET-UP, ALL THE STUDENTS IN THE CLASS WILL BE ABLE TO HEAR THE CONVERSATION. ALSO, THEY WILL BE ABLE TO ENTER IN THE PHONE CONVERSATIONS AND ASK THE SCIENTISTS QUESTIONS.

14. A SPACE BIOLOGY LAB WHICH RELATES TO THE VIKING PROJECT. I HAVE DEVELOPED AND MODIFIED A BSCS LAB TO INCLUDE QUANTITATIVE TESTS THAT STUDENTS CAN RUN WHICH RELATE TO THE VIKING PROJECT AND THE INTRIQUING QUESTION ABOUT LIFE ON MARS. (SEE ATTACHED COPY OF LAB OR CONSULT PAGES 23-24 IN SPACE BOOKLET.)

EVALUATION

THERE IS ROOM FOR THE SPACE BIOLOGY APPROACH IN THE HIGH SCHOOL CURRICULUM. ALTHOUGH I HAVE HAD A VERY UNIQUE EXPERIENCE IN BEING ABLE TO SEE FIRST HAND SOME OF THE SPACE RESEARCH AT AMES, ANY TEACHER CAN INCORPORATE OR INTRODUCE SPACE TOPICS BASED ON READING AND SURVEYING THE LITERATURE. THERE IS A VAST AMOUNT OF MATERIAL AVAILABLE. EACH YEAR THE UNIT HAS BEEN TAUGHT DIFFERENTLY. GRADUALLY THE THINGS WHICH WORKED BEST WERE KEPT AND OTHER THINGS WERE WEEDED OUT. THE SUBJECT IS VERY FLEXIBLE. PORTIONS HAVE BEEN USED WITH TENTH GRADE BIOLOGY CLASSES, BIOLOGY II, AS WELL AS MORE DETAILED PARTS WITH AP STUDENTS. THE SIGN OF A GOOD TEACHER IS THE ABILITY TO MAKE MATERIALS APPLICABLE AND INTERESTING FOR ANY LEVEL HE TEACHES. A GOOD TEACHER IS ALSO ONE THAT CONSTANTLY ATTEMPTS TO FIND WAYS FOR MAKING THE MOST COMPLICATED SUBJECT SIMPLE. THE STUDENTS SEEM TO DERIVE A GREAT DEAL FROM THE EXPERIENCE, BOTH IN GENERAL KNOWLEDGE AND A BROADENING OF SCIENTIFIC SCOPE. LAB REPORTS DONE BY MY STUDENTS HAVE REVEALED SOME GOOD CREATIVE THOUGHT. IT IS ALWAYS FUN TO SEE HOW THEY CAN HANDLE THE DISCUSSION QUESTION GIVEN AT THE END OF THE UNIT. STUDENTS HELP ME IMMENSELY BY BRINGING IN MAGAZINE AND NEWSPAPER ARTICLES. THIS IS ALWAYS A SPECIAL THRILL FOR IT DEMONSTRATES THEIR INTEREST LONG AFTER WE HAVE FINISHED THE UNIT. MANY STUDENTS SEND ME COPIES OF ARTICLES FROM COLLEGE. STUDENTS BORROW MATERIALS FOR SPEECHES AND TERM PAPERS IN OTHER CLASSES. FORMER STUDENTS ATTENDING A NEARBY JUNIOR COLLEGE, OFTEN COME BACK TO BORROW MATERIALS. IT IS TOO EARLY TO GET FEEDBACK FROM AP TEACHERS THAT I SHARED THE SPACE BOOKLET WITH. HOWEVER, I AM ANXIOUS TO SEE IF THEY FOUND THE IDEAS WORKABLE WITH THEIR STUDENTS.

ONE TEACHER WROTE THAT SHE HAD TAKEN THE BOOKLET TO A MUSEUM DIRECTOR AND HE WAS GOING TO WORK WITH HER ON THE VIKING PROJECT IDEA. IT HAS BEEN A CHALLENGE FOR MY STUDENTS AND FOR ME AS A BIOLOGY TEACHER TO TRY TO KEEP UP WITH SUCH A "FAR OUT" SUBJECT.

SPACE BIOLOGY LAB-VIKING PROJECT

INVESTIGATION
SOURCES OF BACTERIAL GROWTH

Do microbes come from nonliving materials, or do they come from pre-existing micro-organisms? In this investigation you will have an opportunity to explore the question for yourself ..

MATERIALS

eight bottles
nutrient broth (400 ml)
cork stoppers for the bottles
s-shaped glass tube 18-20 cm
straight glass tube 8-10 cm.
five cotton plugs for bottles
sealing wax or paraffin
aluminum foil
string
*instant beef broth

Put 50 ml of broth into each flask-

Flask 1 Plug with cotton Do not heat.
Flask 2 Plug with cotton Heat gently in a boiling water bath for 10 minutes.
Flask 3 Heat gently for 10 minutes in a boiling water bath. Leave open....
Flask 4 Heat gently in a boiling water bath for 10 minutes After heating, stopper with a cork. Seal cork to glass with wax
Flask 5 Heat in the pressure cooker or autoclave for 15 minutes- at 15 lbs. pressure. Leave unplugged.
Flask 6 Plug with cotton. Cover the cotton plug and neck of the flask with 1 or 2 layers of aluminum foil. Tie securely-Heat in pressure cooker or autoclave as in flask 5.
Flask 7 Plug with cotton through which the open straight glass tube has been inserted. Heat in the pressure cooker or autoclave.
Flask 8 Plug with cotton through which the s-shaped glass tube has been inserted. Heat in the pressure cooker or autoclave.

The above lab has been taken from the BSCS Blue Version Labs.

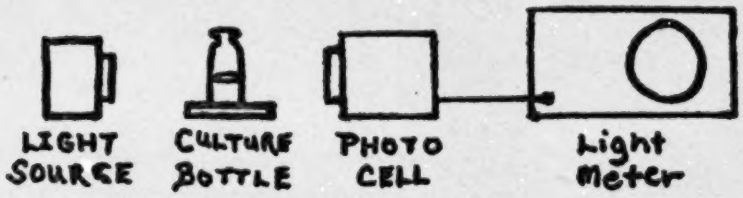
WAYS TO EXPAND LAB

To expand the lab and to introduce students to various quantitative techniques which can be used to approach this and any other biological problem I have incorporated the following:

1. Students are asked to hand in a hypothesis about each bottle before the lab is done. They answer whether they think the bottle will contain microbes and if so, where they think the the microbes will come from
2. Taking the pH reading with paper strips or using pH METER- A beautiful pH reading going from slightly acid to alkaline in bottles which are contaminated-ask why?
3. Students rate the turbidity (cloudiness) of the bottles from one + ++ +++ +++ based on observation of bottles:

4. Students centrifuge two tubes: one they think will be sterile and one that is contaminated.
5. A beef broth is used. Students will have trouble telling whether the sediment in the centrifuge tubes or bottles is salts, fats or microbes. Ask the students to devise a test which will tell whether it is microbes or salts.
6. It students do not come up with the idea, then suggest that a group plate out in petri dishes using aseptic technique a control and a bottle that is in question.
7. Have students do a reading with the photometer. Below, is a diagram of a very simple arrangement which can be used to demonstrate the use of a photometer .

STUDENTS ARE ASKED TO DISCUSS THE WAYS THE VIKING PROJECT PLANS TO TEST FOR LIFE ON MARS. FOR BACKGROUND THEY READ "Life Lab", TIME Sept. 2, 1974 and "Looking for Life on Mars" TIME August 17, 1975.



PHOTOMETER

EXAMPLE

HYPOTHESIS			RESULTS					
TEST TUBE #	MICROB. OR STERILE	SOURCE OF MICROBES	TURBIDITY	pH	SOURCE OF MICROBES	CENTRIFUGE	PHOTOMETER	DESCRIPTION
1	MICROBES	BOTTLE, BROTH, COTTON PLUG	+++	8	NOT heated-pre existing microbes Grow From BOTTLE, BROTH AND COTTON	1/8 ml.	5 UNITS	SURFACE GREEN AND BLACK MOLDS VERY CLOUDY THROUGHOUT BROTH

ANDROMEDA STRAIN by Michael Crichton

QUESTIONS ON BOOK

1. Describe decontamination and quarantine procedures of the five levels in the wild fire lab.

2. What was peculiar about the wounds of the victims found at Piedmont? How did the victims die?

3. Describe how they used filters to determine the size of the Andromeda strain? How large was it?

4. What magnification did they scan the outside of the capsule with?

5. Was Andromeda transmitted by dead animals?

6. Was Andromeda transmitted by air? Explain.

7. How was the watch, black cloth and rock used to discuss living vs non living things?

8. How was the spectrometer used p. 197? How does it work?

9. The Andromeda was made of what four elements?

10. What did amino acid analysis reveal? What was strange about it?

11. What did the electron microscope reveal about the structure of the of the microbe?

12. The only survivors were a young baby and an old man. Explain why <u>each</u> case survived.

13. How did they go about trying to <u>culture</u> and <u>grow</u> the organism?

14. What was your opinion about the way the author ended the book?

ADVANCED PLACEMENT EXAMINATION BIOLOGY QUESTION

1. You have only a small amount (e.g. 1 gram) of substance obtained from another planet under sterile conditions. List the criteria you would use to determine whether this material is alive. Without elaborating on techniques, describe one experiment that might be used to demonstrate each of your criteria. Indicate what you would do to insure sterility and to complete the necessary experiments with the limited amount of material you have.

TOPICS

I. "During Months of Weightlessness on the Way to Mars"; Life 1969; written about Dr. Jiro Oyama, Chief of Physiology, authority on experiments with centrifuge at Ames; he was the scientist I was assigned to and directed my research.

II. "Hypothermia in Rats Subjected to Acute Centrifugation"; by Janice Lamb.

III. "The Organism in Space"; by Dr. Eric Ogden, Ames.

IV. Heterotroph vs. Autotroph theory- "Hour Glass Theory".

V. Paleobiogeochemistry- A discussion of micro and chemical fossils.

VI. Martian Environment lecture by Dr. Harold Klein, Extraterrestrial Biology authority at Ames; covers Miller-Urey and the work of other chemical evolutionists.

VII. "Florida Scientist Awaits Moon Matter"; about Dr. Sidney Fox and his role in analysis of moon rocks.

VIII. "Two biologists see possibility that Life May exist on Mars"; about Dr. Klein and Dr. Ponnamperuma's work (both lectured at Ames). "Possible Link to Beginning of Life Found" 1974; Ames Scientists Synthesize Chemical Compound Chlorophyll".

IX. "Life Lab"; Time 1974; about the one million dollar Viking Project to go off August 1975 from Florida; "Looking For Life on Mars"; Time August 17, 1975.

X. Microbe Lab (modified to introduce quantitative analysis techniques-various way to approach the origin of life problem).

XI. Questions on the book Andromeda Strain , by Michael Crichton; given to my students as a report after they read the book.

XII. Example of advanced placement discussion question.

(FROM Advanced Placement Space Biology booklet)

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